

Claims

1. In a computer system having local resources that a program may use, a method comprising the computer-implemented steps of:

providing a resource planner for planning resource allocation in the computer system, comprising:

a policy module for implementing a policy for arbitrating among requests to reserve resources;

an independent planning engine that is separate from the policy module but that implements the policy of the policy module;

receiving at the resource planner a request for a program to reserve a resource; and

using the resource planner to determine whether to grant the request.

2. The method of claim 1 wherein the computer system includes a different policy module for implementing a different policy for arbitrating among requests to reserve resources and wherein the method further comprises the step of using the different policy in the independent planning engine.

3. The method of claim 1 wherein the resource planner is an object and the policy module is an interface supported by the resource planner.

4. The method of claim 1 wherein the request to reserve a resource requests to reserve specific amounts of resources.

5. The method of claim 1 wherein the resource planner is a separate entity from the program that issues the request to reserve a resource.

6. The method of claim 1 wherein the program that issues the request is a real-time application program.

7. In a computer system having local resources a method comprising the computer-implemented steps of:

concurrently running multiple real-time application programs that require at least some of the local resources on the computer system;

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providing a resource planner that the programs must contact to reserve the local resources, said resource planner implementing a universal policy for arbitrating among requests for the local resources;

receiving at the resource planner requests for at least some of the local resources from the real-time application programs running on the computer system; and

in the resource planner, arbitrating among the requests to grant or deny reservations for at least some of the local resources to the real-time application programs that submitted the requests.

8. The method of claim 7 wherein the resource planner is distinct from the real-time application programs.

9. The method of claim 7 wherein the resource planner is distinct from the resources.

10. In a computer system having resources, a method comprising the computer-implemented steps of:

providing a computer-implemented resource planner for granting reservations of shares of the local resources in response to requests;

receiving at the resource planner a request from a first program to reserve a first share of a selected one of the resources;

receiving at the resource planner a request from a second program to reserve a second share of the selected resource, wherein said second program is not aware of said first program; and

with the resource planner, granting the first program a reservation for the first share of the selected resource and granting the second program a reservation for the second share of the selected resource so that the first program and second program may share the selected resource.

11. In a computer system that runs processes having threads, said computer system having resources for use by the processes and threads, a method comprising the computer-implemented steps of:

providing a resource planner for granting reservations of shares of the resources;

receiving at the resource planner a request for an activity to reserve a share of at least one resource wherein said activity includes at least portions of multiple processes;

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processing the request with the resource planner; and  
granting the request so that the share of the at least one resource is reserved for use by the activity.

12. The method of claim 11 wherein the computer system is a distributed system that includes multiple computers and wherein the processes for which at least a portion of are included in the activity run on at least two of the computers.

13. The method of claim 11, further comprising the steps of:  
receiving an additional request from an additional activity to reserve a share of at least one of the resources; and  
processing the additional request with the resource planner to decide whether or not to grant the additional request.

14. The method of claim 11 wherein the activity in the request requests shares of multiple ones of the resources.

15. The method of claim 11 wherein the request includes a resource set that specifies a requested share for each resource for which a reservation is requested.

16. The method of claim 11 wherein the resource planner is a separate entity from the activity.

17. The method of claim 11 wherein the activity is part of a real-time program.

18. In a computer system having resources for use by activities, a method comprising the computer-implemented steps of:

providing a resource planner for granting reservations for shares of the resources;

running an activity on the computer system wherein the activity is aware of its resource requirements;

submitting a request to the resource planner to obtain a reservation for a share of at least one of the resources that reflect the resource requirements of the activity;

processing the request in the resource planner to grant or deny the request.

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19. The method of claim 18, further comprising the step of, with the activity, using the resources for which a reservation was granted.

20. The method of claim 18 wherein the activity is a program.

21. The method of claim 18 wherein the activity is a process.

22. The method of claim 18 wherein the activity is a thread.

23. In a computer system having resources and a resource planner for granting reservations of amounts of resources to activities, a method comprising the computer-implemented steps of:

from an activity, submitting a request for a reservation of a set of resources in specified amounts to the resource planner;

with the resource planner, processing the request and determining that the request may not be granted; and

returning to the activity from the resource planner a list of amounts of the set of resources that are currently available to the activity.

24. The method of claim 22, further comprising the steps of using the returned list to reformulate the request for a reservation of the set of resources to specify new requested amounts and resubmitting the request to the resource planner.

25. In a computer system having resources and a resource planner for granting reservations of amounts of resources to activities performed on the computer system, a method comprising the computer-implemented steps of:

negotiating between the resource planner and activities to reserve shares of the resources with the resource planner on behalf of the activities; and

in view of changing resource usage or requirements, renegotiating between the resource planner and the activities to change reservations of resources on behalf of the activities to reflect the changing resource usage or requirements.

26. The method of claim 25 wherein the changing resource usage or requirements are the product of a new activity being performed.

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27. The method of claim 25 wherein the changing resource usage or requirements are the product of an activity changing its resource requirements.

28. The method of claim 25 wherein the changing resource usage or requirements are the product of an activity no longer being performed.

29. The method of claim 25 wherein the changing resource usage or requirements are the product of a persistent overload of use of a resource.

30. The method of claim 25 wherein the changing resource usage requirements are the product of a change in resource allocation policy.

31. In a computer system having an initial set of resources a resource planner and activities that seek to use the resources, a method comprising the computer-implemented steps of:

managing allocation of use of the initial set of resources by the activities with the resource planner;

altering what resources are in the computer system so that a new set of resources are in the computer system; and

adapting to the altering of what resources are in the computer system with the resource planner to manage allocation of use of the new set of resource by activities with the resource planner, without interruption of operation of the resource planner.

32. The method of claim 31 wherein the step of altering what resources are in the computer system comprises the step of adding at least one resource to the system.

33. The method of claim 31 wherein the step of altering what resources are in the computer system comprises the step of removing at least one resource from the system.

34. In a computer system, performing an activity and having resources that may be used by the activities and resource providers that manage access to the resources, a method comprising the computer-implemented steps of:

with an activity, querying a first resource provider that is called by the activity to perform an operation on behalf of the activity to determine a first set of resource requirements to perform the operation on behalf of the activity;

with the first resource provider, querying a second resource that is called by the first resource provider to complete the operation on behalf of the activity provider to determine a second set of resource requirements for the second resource provider to perform its role in the operation that is performed on behalf of the activity;

determining the first set of resource requirements to be a sum of the second set of resource requirements and any additional resource requirements for actions performed directly by the first resource provider to complete the operation on behalf of the activity; and

determining resource requirements of the activity to be a sum of the first set of resource requirements and any additional resource requirements of the activity.

35. The method of claim 34 wherein the resource providers support interfaces of methods and the querying steps are performed by calling methods of the interfaces.

36. In a distributed system having computer systems connected by network connectors, wherein each computer system performs activities and has local resources and a local resource planner that allocates reservations of shares of the local resources to activities, a method comprising the steps of:

at one of the computer systems, receiving a request for a reservation of a share of a remote resource at a selected one of the computer systems from an activity at the local resource planner;

forwarding the request to the local resource planner at the selected one of the computer systems;

processing the request at the local planner of the selected one of the computer systems to generate a response to the request; and

returning the response to the activity that initiated the request.

37. A computer system comprising:  
resources;

programs that require the use of at least some of the resources; and

a resource planner that is independent of the programs and the resources for issuing reservations to the programs to use shares of at least some of the resources in response to requests submitted by the programs.

38. The computer system of claim 37 wherein the resource planner further comprises:

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a policy module for establishing policy for arbitrating among requests from the programs;

an independent mechanism that is independent from the policy module for implementing the policy established by the policy module.

39. The computer system of claim 37, further comprising a resource provider for each resource for providing information about resource requirements to perform operations on the resource.

40. The computer system of claim 37, wherein the computer system comprises multiple computers having local resources and wherein the resource planner further comprises a local component on each computer system that manages the local resources of the computer system and means for facilitating cooperation among the local components for managing remote resources.

41. The computer system of claim 37 wherein at least one of the programs is a real-time program.

42. The computer system of claim 37 where the resources include a file system.

43. The computer system of claim 37 wherein the resources include disk bandwidth.

44. The computer system of claim 37 wherein the computer system is part of a network and wherein the resources include network bandwidth.

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